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THE BEDBUG.[1]

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INTRODUCTION.

The presence of the bedbug (fig. 1) in a house is not necessarily an indication of neglect or carelessness; for, little as the idea may be relished, this insect may gain access in spite of the adoption of all reasonable precautions. It is very apt to get into the trunks and satchels of travelers, or into baskets of laundry, and may thus be introduced into homes. Unfortunately, also, it is quite capable of migrating from one house to another and will often continue to come from an adjoining house, sometimes for a period of several months, gaining entrance daily. Such migration is especially likely to take place if the human inhabitants of an infested house leave it. With the failure of their usual source of food, the migratory instinct of the bedbugs is developed, and, escaping through windows, they pass along walls, water pipes, or gutters, and thus gain entrance into adjoining houses. In these or other ways anyone's premises may be temporarily invaded.

[1] *Cimex lectularius* L.; order Hemiptera, suborder Heteroptera, family Cimicidae.

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ORIGIN; COMMON NAMES; DISTRIBUTION.

As with nearly all the insects associated with man, the bedbug has had the habits now characteristic of it as far back as the records run. It was undoubtedly of common occurrence in the dwellings of the ancient peoples of Asia. The Romans were well acquainted with it, giving it the name Cimex. It was supposed by Pliny—and this was doubtless the common belief among the Romans—to have medicinal properties, and it was recommended, among other things, as a specific for the bites of serpents. It is said to have been first introduced into England in 1503, but the references to it are of such a nature as to make it very probable that it had been there long before. Two hundred and fifty years later it was reported to be very abundant in the seaport towns, but was scarcely known inland.

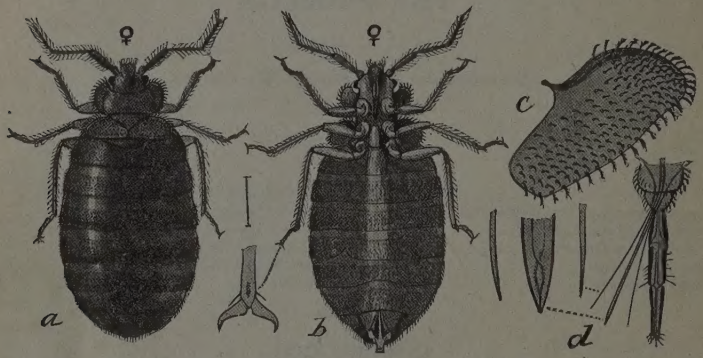

FIG. 1.—Bedbug (*Cimex lectularius*): *a*, Adult female, engorged with blood; *b*, same from below; *c*, rudimentary wing pad; *d*, mouth parts. *a*, *b*, Much enlarged; *c*, *d*, highly magnified. (Author's illustration.)

One of the old English names was "wall-louse." It was afterward very well known as the "chinch," which continued to be the common appellation for it until within a century or two, and is still used in parts of this country. The origin of the name "bedbug" is not known, but it is such a descriptive one that it would seem to have been very naturally suggested. Almost everywhere there are local names for these parasites, as, for illustration, around Boston they are called "chintzes" and "chinches," and from Baltimore comes the name "mahogany flat," while in New York they are styled "red coats," and in the west "crimson ramblers."

The bedbug has accompanied man wherever he has gone. Ships are very apt to be infested with it and have been the chief means of its wide distribution. It probably came to this country with the earliest colonists; at least Kalm, writing in 1748–49, stated that it was plentiful in the English colonies and in Canada, though unknown among the Indians.

VARIETIES AND RELATED INSECTS.

What may eventually prove to be mere variations of the ordinary type of human bedbug have been described as distinct species in several instances. For example, the common bedbug of southern Asia is supposed to present some slight variations from the European type, chiefly in being somewhat more elongate. These slightly diverging forms of the bedbug in different parts of the world, which are not known to have any special bird or animal host other than human beings, may prove to be merely local races or varieties of the ordinary bedbug.

Birds, bats, and poultry are attacked in various parts of the world by a considerable number of parasitic bugs, closely related to the bedbug, which live on their hosts and in nests and about roosting places. One of these species, occurring abundantly in southwestern United States and Mexico,[1] probably originally a parasitic messmate on birds and bats, has come to be an unmitigated poultry pest, and from the close association in these regions between poultry and human beings, is often a serious house pest—more so even than the true bedbug. Others of the species infesting birds and bats may also on occasion become house pests. For example, the nests of the common barn or eaves swallow of this country often swarm with the barn-swallow bug,[2] and from such nests under the eaves of dwelling houses these bugs sometimes gain entrance to houses and beds and are the cause of much annoyance. Similarly a species,[3] normally a parasite of birds and bats in the Old World, and also in Brazil and the West Indies, not infrequently becomes a human parasite.

GENERAL CHARACTERISTICS.

The bedbug belongs to the order Hemiptera, which includes the true bugs or piercing insects, characterized by possessing a piercing and sucking beak. The bedbug is to man what the chinch bug is to grains or the squash bug to cucurbs. Like nearly all the insects parasitic on animals, however, it is degraded structurally, its parasitic nature and the slight necessity for extensive locomotion having resulted, after many ages doubtless, in the loss of wings and the assumption of a comparatively simple structure. Before feeding, the adult (fig. 2) is much flattened, oval, and in color is rust red, with the abdomen more or less tinged with black. When engorged the body becomes much bloated and elongated and brightly colored from the ingested blood. The wings are represented by the merest rudiments, barely recognizable pads, and the simple eyes or ocelli

[1] (*Cimex*) *Haematosiphon inodora* Dugès.
[2] (*Cimex*) *Oeciacus hirundinis* Jenyns.
[3] *Cimex hemipterus* Fab. (synonym, *rotundatus* Sign.).

of most other true bugs are lacking. The absence of wings is a most fortunate circumstance, since otherwise there would be no safety from it even for the most careful of housekeepers. Some slight variation in length of wing pads has been observed, but none with wings showing any considerable development has ever been found.

THE "BUGGY" ODOR.

The most characteristic feature of the bedbug is the very distinct and disagreeable odor which it exhales, an odor well known to all who have been familiar with it as the "buggy" odor. This odor is by no means limited to the bedbug, but is characteristic of most plant bugs also. The common chinch bug affecting small grains and the squash bugs all possess this odor, and it is quite as pungent with these plant-feeding forms as with the human parasite. The possession of this odor, disagreeable as it is, is very fortunate after all, as it is of considerable assistance in detecting the presence of these vermin. The odor comes from glands, situated in various parts of the body, which secrete a clear, oily, volatile liquid. With the plant-feeding forms this odor is certainly a means of protection against insectivorous birds, rendering these insects obnoxious or distasteful to their feathered enemies. With the bedbug, on the other hand, it is probably an illustration of a very common phenomenon among animals, i. e., the persistence of a characteristic which is no longer of any especial value to the possessor. The natural enemies of true bugs, against which this odor serves as a means of protection, in the conditions under which the bedbug lives, are kept away from it; and the roach, which sometimes feeds on bedbugs, is evidently not deterred by the odor, while the common house ant and the house centipede, which may also attack the bedbug, seem not to find this odor disagreeable.

FIG. 2.—Bedbug: Adult before engorgement. Much enlarged. (Author's illustration.)

HABITS AND LIFE HISTORY.

The bedbug is normally nocturnal in habits and displays a certain degree of wariness, caution, and intelligence in its efforts at concealment during the day. Under the stress of hunger, however, it will emerge from its place of concealment in a well-lighted room at night, so that under such circumstances keeping the gas or electric light burning is not a complete protection. It has been known under similar conditions to attack human beings voraciously in broad

daylight. It usually leaves its victim as soon as it has become engorged with blood and retires to its normal place of concealment, either in cracks in the bedstead, especially if the latter be one of the wooden variety, or behind wainscoting, or under loose wall paper, and in these and similar places it manifests its gregarious habit by collecting in masses. It thrives particularly in filthy apartments and in old houses which are full of cracks and crevices, in which it can conceal itself beyond easy reach. As just noted the old-fashioned, heavy, wooden-slatted bedsteads afford especially favorable situations for the concealment and multiplication of this insect, and the general use in later years of iron and brass bedsteads has very greatly facilitated its eradication. Such beds, however, do not insure safety, as the insects are able to find places of concealment even about such beds, or get to them readily from their other hiding places.

Extraordinary stories are current of the remarkable intelligence of this insect in circumventing various efforts to prevent its gaining access to beds. Most of these are undoubtedly exaggerations, but the inherited experience of many centuries of companionship with man, during which the bedbug has always found its host an active enemy, has resulted in a knowledge of the habits of the human animal and a facility of concealment, particularly as evidenced by its abandoning beds and often going to distant quarters for protection and hiding during daylight, which indicate considerable apparent intelligence.

Like its allies, the bedbug undergoes what is known as an incomplete metamorphosis. In other words, the insect from its larval to its adult stage is active and similar in form, structure, and habit, contrasting with flies and moths in their very diverse life stages of larva, chrysalis, or pupa, and winged adult.

The eggs (fig. 3, *d*) are white oval objects having a little projecting rim around one edge and may be found in batches of from 6 to 50 in cracks and crevices where the parent bugs go for concealment. In confinement eggs may be deposited almost daily over a period of two months or more and commonly at the rate of from one to five eggs per day, but sometimes much larger batches are laid. As many as 190 eggs have been thus obtained from a single captured female.[1]

The eggs hatch in a week or 10 days in the hot weather of midsummer, but cold may lengthen or even double this egg period or check development altogether. The young escape by pushing up the lid-like top with its projecting rim. When first emerged (fig. 3, *a*, *b*) they are yellowish white and nearly transparent, the brown color of the more mature insect increasing with the later molts (fig. 4).

[1] Girault, A. A. Preliminary studies on the biology of the bedbug, *Cimex lectularius*, Linn. III, Facts obtained concerning the habits of the adult. *In* Jour. Econ. Biol., v. 9, no. 1, p. 25–45. 1914.

During the course of its development the bedbug molts or sheds its skin normally five times, and with the last molt the minute wing pads, characteristic of the adult insect, make their appearance. A period of about 11 weeks was formerly supposed to be necessary for the complete maturity of the insect, but breeding experiments with

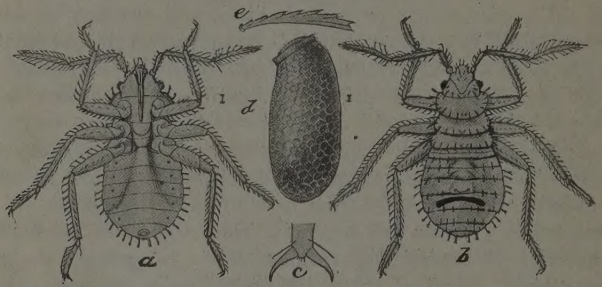

FIG. 3.—Bedbug: Egg and newly hatched larva: *a*, Larva from below; *b*, larva from above; *c*, claw; *d*, egg; *e*, hair or spine of larva. Greatly enlarged, natural size of larva and egg indicated by hair lines. (Author's illustration.)

this insect, conducted in this department in 1896, indicated that the life cycle is subject to great variation, being entirely dependent on warmth and food supply. Under favorable conditions of temperature and food it was found that there was an average period of about eight days between moltings and between the laying of eggs and their hatching, giving about seven weeks as the period under these

FIG. 4.—Bedbug: *a*, Larval skin shed at first molt; *b*, second larval stage immediately after emerging from *a*; *c*, same after first meal, distended with blood. Greatly enlarged. (Author's illustration.)

conditions from egg to adult insect. The molting periods are shorter in the earlier stages and lengthen in the later stages. There are many exceptions, however, and some individuals even under the same conditions remain two or three weeks without molting. Under conditions of famine, or without food, as already shown, the bedbug may remain unchanged in any of the immature stages for an indefinite

time, and the checking of development by such starvation may result in additional molting periods.

The breeding records referred to, and numerous confirmatory experiments subsequently made by other investigators, indicate that ordinarily but one meal is taken between molts, so that each bedbug must puncture its host five times before becoming mature, and at least once afterwards before it can develop eggs. Additional meals between molts may be taken under favoring circumstances, however, and particularly when the insect has been disturbed and has not become fully engorged at its first meal after a molting or other period. The bedbug takes from 5 to 10 minutes to become bloated with blood, and then retires to its place of concealment for 6 to 10 days for the quiet digestion of its enormous meal, and for subsequent molting, or reproduction if in the adult stage.

Such feeding and reproduction may, under favorable conditions of temperature, continue throughout the year, and in one instance the progeny of a captured female adult was carried through three continuous generations.[1]

Unfavorable conditions of temperature and food will necessarily result in great variation in the number of generations annually and in the rate of multiplication, but allowing for reasonable checks on development, there may be at least four successive broods in a year in houses kept well heated in winter.

FOOD AND LONGEVITY.

Under normal conditions the food of the common bedbug is obtained from human beings only, and no other unforced feeding habit has been reported. It is easily possible, however, to force the bedbug to feed on mice, rats, birds, etc., and probably it may do so occasionally in nature in the absence of its normal host. The abundance of this insect in houses which have long been untenanted may occasionally be accounted for by such other sources of food, but probably normally such infestation can be explained by the natural longevity of the insect and its ability to survive for practically a year, and perhaps more, without food.

There are many records indicating the ability of the bedbug to survive for long periods without food, and specimens have been kept for a year in a sealed vial with absolutely no means of sustenance whatever. In the course of the department's study of this insect in 1896, young bedbugs, obtained from eggs, were kept in small sealed vials for several months, remaining active in spite of the fact that they had never taken any nourishment whatever. A considerable

[1] Girault, A. A. Preliminary studies on the biology of the bedbug, *Cimex lectularius*, Linn. II. Facts obtained concerning the duration of its different stages. *In* Jour. Econ. Biol., v. 7, no. 4, p. 163–188. 1912.

series of experiments was later conducted by Girault,[1] bearing on the longevity of the insect under different conditions. A large number of adults of both sexes were kept in confinement, but with normal feeding and mating, and these survived for periods ranging from 54 to 316 days. Similarly, the life of 71 newly hatched larvæ, without food, ranged from 17 to 42 days, averaging about 28 days. Partly grown captured insects lived without further feeding from 17 to 60 days. Longevity is naturally affected more or less by temperatures. In other words, temperatures sufficient to check the activity of the insect and produce hibernation or semihibernation are apt to increase longevity.

The fact that the bedbug is able to survive for such long periods without human blood has led to the theory that it could subsist in some fashion on the moisture from wood or from accumulations of dust in crevices in flooring, etc. There seems to be no basis of observed fact for this idea.

Another very prevalent belief among the old settlers in the West, that this insect normally lives on dead or diseased cottonwood logs, and is almost certain to abound in log houses of this wood, seems to be equally devoid of basis. As illustrating this belief, the department has on file a very definite report from an Army officer that the bedbug often occurs in numbers under the bark of dead cottonwood trees,[2] especially along the Big Horn and Little Horn Rivers in Montana. The basis of this report and the origin of this very general misconception is probably, as pointed out by the late Prof. Riley, due to a confusion of the bedbug with the immature stages of an entirely distinct insect,[3] which somewhat resembles the bedbug and often occurs under cottonwood bark.

INFLUENCE OF TEMPERATURE.

As a messmate of human beings in dwelling houses, the bedbug is normally protected from extreme cold, and is known to be an abundant and serious pest far north. In fact, it is often more troublesome in north temperate latitudes than farther south. This may be accounted for partly by the fact that the bedbug is very sensitive to high temperatures, and a temperature of 96° to 100° F. or more, accompanied with a fairly high degree of humidity, results in the death of large numbers of the bugs. The mature or partly mature bedbugs can stand comparatively low temperatures, even below freezing, for a considerable period. The eggs and newly hatched larvæ, however, succumb to a temperature below freezing, if this condition is prolonged for from 15 days to a month. The feeding and developing activity of the insect practically ceases at 60° F., the insect remaining quiescent and in semihibernation at

[1] Loc. cit. [2] *Populus monilifera*. [3] *Aradus* sp.

temperatures below this point. The most favorable temperatures for activity are between 60° and 98° F.[1] The activity of the insect is controlled entirely by temperature and food supply, and, therefore, in heated houses the insect may remain active throughout the winter. There is some protection in winter, therefore, in sleeping in cold bedrooms.

THE BITE OF THE BEDBUG.

The bite of the bedbug is decidedly poisonous to some individuals, resulting in a slight swelling and disagreeable inflammation. To such persons the presence of bedbugs is sufficient to cause the greatest uneasiness, if not to put sleep and rest entirely out of the question. With others, however, who are less sensitive, the presence of the bugs may not be recognized at all, and, except for the occasional staining of the linen by a crushed individual, their presence might be entirely overlooked. The inflammation experienced by sensitive persons seems to result chiefly from the puncture of the skin by the sharp piercing setæ which constitute the puncturing element of the mouth parts, as there seems to be no secretion of poison other than the natural fluids of the mouth.

The biting organ of the bedbug is similar to that of other insects of its order. It consists of a rather heavy, fleshy under lip (the only part ordinarily seen in examining the insect), within which lie four threadlike hard filaments or setæ which glide over one another with an alternating motion and pierce the flesh. The blood is drawn up through the beak, which is closely applied to the point of puncture, and the alternating motion of the setæ in the flesh causes the blood to flow more freely. The details of the structure of the beak are shown in figure 1 at *d*.

To allay the irritation set up by the bite of the bedbug, peroxide of hydrogen, or dioxygen, may be used with good results.

Tincture of iodine either at ordinary or double strength is also a good counter-irritant for use in cases of flea, mosquito, bedbug, and other insect bites, but should be used with caution on the tender skin of small children and on those who are affected with or disposed to eczemic disorders.

THE BEDBUG AND HUMAN DISEASES.

In common with other insects which attack man and warm-blooded animals, it is entirely possible for the bedbug and its close allies to be transmitters of contagious human diseases, and already these insects have been shown to be possible carriers or transmitters of a considerable series of diseases, including infantile Kala-azar of northern Africa and southern Europe, relapsing fever of Africa and Europe, the Chagas fever of Brazil, tropical sore, plague, and possibly

[1] Bacot, A. W. The influence of temperature, submersion, and burial on the survival of eggs and larvæ of *Cimex lectularius*. *In* Bul. Ent. Res., v. 5, pt. 2, p. 111–117. 1914.

leprosy. In the case of these, and perhaps other diseases, the bedbug shares the responsibility of transmitter with other biting insects, such as body lice and fleas.

The particular rôle of the bedbug as a carrier of disease has not been satisfactorily determined, nor has it been shown that the bedbug is a necessary alternate host in any instance. In general, the transmission of disease by this insect has apparently resulted from the accidental carriage of the disease elements on the mouth parts, as pointed out by André,[1] after a careful study of the subject. As a parasite of human beings in private dwelling houses, where it may seldom change its host, the opportunity for the bedbug itself to become infected with human diseases and again to transmit them to the human subject is very remote. This condition, however, does not apply to hotels or to passenger boats, where the human occupants are constantly changing. Furthermore, the fact that the bedbug attacks its host at comparatively long intervals of from a week to several weeks or months acts as a bar to its transmission of certain insect-borne diseases, the biology of which requires a definite and comparatively short period of development in the alternate insect host.

NATURAL ENEMIES OF THE BEDBUG.

Living always in houses as it does and being well concealed, the bedbug is not normally subject to much if any control by natural enemies. Certain other household insects, however, do occasionally prey upon the bedbug, as, for example, the house centipede [2] and the common little red house ant.[3] Such enemies, however, are of very small importance and yield little, if any, effective control except under very exceptional circumstances. One such instance is reported by the late Mr. Theodore Pergande, of this department, who states that as a soldier in the Civil War he occupied at one time a barracks at Meridian, Miss., which had been abandoned some time before. The premises proved to be swarming with bedbugs; but very shortly afterwards the little red house ant discovered the presence of the bedbugs and came in enormous numbers, and Mr. Pergande witnessed the very interesting and pleasing sight of the bedbugs being dismembered and carried away bodily by these very minute ants, many times smaller than the bugs which they were handling so successfully. The result was that in a single day the bedbug nuisance was completely abated. The liking of red ants for bedbugs is confirmed also by a correspondent writing from Florida (F. C. M. Boggess), who goes so far as heartily to recommend the artificial introduction of the ants

[1] André, Ch. Recherches anatomiques et expérimentales sur la punaise des lits. *In* Jour. Physiol. et Path. Gén., v. 14, p. 600–615. 1912.

[2] *Scutigera forceps* Raf.

[3] *Monomorium pharaonis* L.

to abate this bug nuisance.[1] Bedbugs and other household insects, however, are not of the sort which it is convenient or profitable to turn over to their natural enemies in the hope that eradication by this means will follow, and the fact that they are preyed upon by other insects furnishes no excuse to the housekeeper for not instituting prompt remedial measures.

REMEDIES.

Undoubtedly the most efficient remedy for the bedbug is to fumigate the infested house or rooms with hydrocyanic-acid gas. This gas will penetrate into every crevice in the house or room where the bedbugs conceal themselves and has an immediate effectiveness which gives it an important recommendation, especially when the infestation is considerable or of long standing. This method of fumigation should be intelligently employed, as the gas is deadly poisonous. A bulletin giving directions for such fumigation has been issued by the Department of Agriculture.[2]

The fumes of burning sulphur are also a very efficient means of control where the conditions are such that this method can be used, readily destroying the insect in all stages, including the egg. The treatment is inexpensive compared with the use of hydrocyanic-acid gas and offers much less risk of danger to human beings. There is, however, a considerable risk of injury to household fabrics, furnishings, and wall papers from the strong bleaching quality of sulphur fumes. This danger will be somewhat diminished if the fumigation can be done at a time when the room or house is thoroughly dried out, as in winter by a furnace or other heating system. Further precautions should be taken by removing all metallic surfaces from the room or building, or by protecting them with a coating of vaseline. Two pounds of sulphur are recommended for each 2,000 cubic feet of space, and the building should be closed for the treatment for at least 5 or 6 hours, or preferably for 24 hours. Sulphur candles may be used where available, or the sulphurous gas or fumes can be generated by burning the sulphur in a dish placed in the center of the room, and for protection set within a larger vessel. Thorough-going precautions must be taken to prevent accidental overflowing or the starting of a fire, and after the fumigation the house should be given a thorough airing.

Other gases have been experimented with, such as formalin and the vapors of benzine, naphthaline, and camphor, but these gases are of little value. Similarly, insect powders are of little value, largely from the difficulty of getting them into the crevices and other places of concealment of the insects.

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[1] Bedbugs and red ants. *In* Insect Life, v. 6, no. 4, p. 340. 1894.

[2] Howard, L. O., and Popenoe, C. H. Hydrocyanic-acid gas against household insects. U. S. Dept. Agr. Farmers' Bul. 699. 8 p. 1916.

The old-fashioned household remedies referred to below are effective enough, though at a greater cost of time and personal effort. They will, however, be often of much service in the case of slight or recent infestations, or where the employment of more poisonous and troublesome gases is objected to or is impracticable. Of these simple methods of control perhaps the most efficient is in very liberal applications of benzine or kerosene, or any other of the lighter petroleum oils, introduced with small brushes or feathers, or by injecting with syringes into all crevices of beds, furniture, or walls where the insects may have concealed themselves. Corrosive sublimate is also of value, and oil of turpentine may be used in the same way. The liberal use of hot water, wherever it may be employed without danger to furniture, etc., is also an effectual method of destroying both eggs and active bugs.[1]

Various bedbug remedies and mixtures are for sale, most of them containing one or another of the ingredients mentioned, and these are frequently of value. The great desideratum, however, in a case of this kind, is a daily inspection of beds and bedding, particularly the seams and tufting of mattresses, and of all crevices and locations about the premises where these vermin may have gone for concealment. A vigorous campaign should, in the course of a week or so at the outside, result in the extermination of this very obnoxious and embarrassing pest.

The possibility of temperature control is indicated in the discussion elsewhere of the effect of temperature on this insect, and it may be that if infested houses in cold climates could be opened up and allowed to remain at a temperature well below freezing for a week or more, the bedbug would be thoroughly exterminated. This method of control would be rarely practicable except perhaps in the case of summer houses which are left untenanted in winter.

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[1] A remedy for the bedbug has been devised by Mr. R. H. Pettit ("Notes on two insecticidal agents," *in* 10th Rpt. Mich. Acad. Sci., p. 159–160, 1908) as a substitute for hydrocyanic-acid gas and sulphur, and is reported to have proved very successful. The preparation of this insecticide and its application is described as follows:

Alcohol is drawn through pyrethrum in a funnel until the powder is well washed and a large part of the resinous principle extracted. To do this, the powder is placed in a large funnel with filter-plate and a layer of cotton wool at the bottom. An aspirator is attached and the alcohol is at first slowly and later rapidly sucked through six or eight times, during which operation it becomes highly colored. To this liquid as a basis, are added several oils to give permanence to the application. Both alcohol and pyrethrum evaporate so quickly that it was thought best to carry in some heavier volatile oils whose effects would last several days or even weeks. The formula when completed stands as follows:

To the extract made by washing 400 grams of pyrethrum with 2,000 c. c. of strong alcohol, are added—

50 grams gum camphor.
150 c. c. cedar wood oil.
25 grams oil citronella.
25 grams oil lavender.

The application is best made with a large sized atomizer, one holding a pint or more and working with a piston instead of a rubber bulb. * * * To obtain the best results, repeat the treatment after about two weeks. We have tried this mixture repeatedly, and with uniformly gratifying results. Usually one application, if thoroughly made, put a period to the complaints, about eight or ten ounces being required in an average sleeping-room. The odor remains some little time in a room, but is not disagreeable to the average person.

This remedy can be readily prepared by a pharmacist in any drug store.